CHAPTER 21

Network Layer: Address Mapping, Error Reporting, and Multiplexing

Solutions to Review Questions and Exercises

Review Questions

1. The size of an ARP packet is ***variable***, depending on the length of the logical and physical addresses used.
2. ARP Packet Size = 2 + 2 + 1 + 1 + 2 + 6 + 4 + 6 + 4 = **28 bytes**
3. The size of the ARP packet in Question 2 is 28 bytes. We need to pad the data to have the minimum size of **46**. The size of the packet in the Ethernet frame is then calculated as 6 + 6 + 2 + **46** + 4 = **64 bytes** (without preamble and SFD).
4. The broadcast for Ethernet is all 1s or **0xFFFFFFFFFFFF**.
5. This restriction prevents ICMP packets from ***flooding*** the network. Without this restriction an endless flow of ICMP packets could be created.
6. The ***IP header*** is included because it contains the IP address of the original source. ***The first 8 bytes of the data*** are included because they contain the first section of the TCP or UDP header which contains information about the port numbers (TCP and UDP) and sequence number (TCP). This information allows the source to direct the ICMP message to the correct application.
7. A host would never receive a redirection message if there is only ***one router*** that connects the local network to the outside world.
8. The minimum size of an ICMP packet is **8 bytes** (router solicitation packet). The largest of the ICMP packets is the router advertisement packet with up to 255 listings. The maximum size is then:

   255 listings × 8 bytes/listing + 8 bytes for the ICMP header = **2048 bytes**

9. The minimum size of an IP packet that carries an ICMP packet would be **28 bytes** (a 20 byte IP header + an 8 byte router solicitation packet). The maximum size would be **2068 bytes** (a 20 byte IP header + a 2048 byte router advertisement packet).
10. The value of the ***protocol field*** of an IP packet carrying an ICMP packet is **1**.
11. The minimum size would be **64 bytes** if we do not consider the preamble and SFD fields, which are added at the physical layer. The maximum size would be **1518**

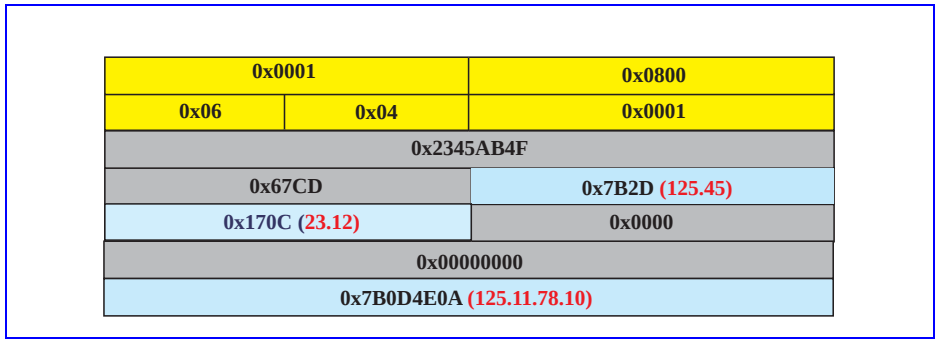
bytes, again not considering the preamble and SFD fields. Although the maximum size of an ICMP packet can be much more than 1500 bytes (for a router advertisement packet), Ethernet can carry only 1500 bytes of it.

12. There is no need for a report message to travel outside of its own network because its only purpose is to ***inform the next router in the spanning tree of group membership***. There is no need for a query message to travel outside of the local network because its only purpose is ***to poll the local network for membership in any groups***.

Exercises

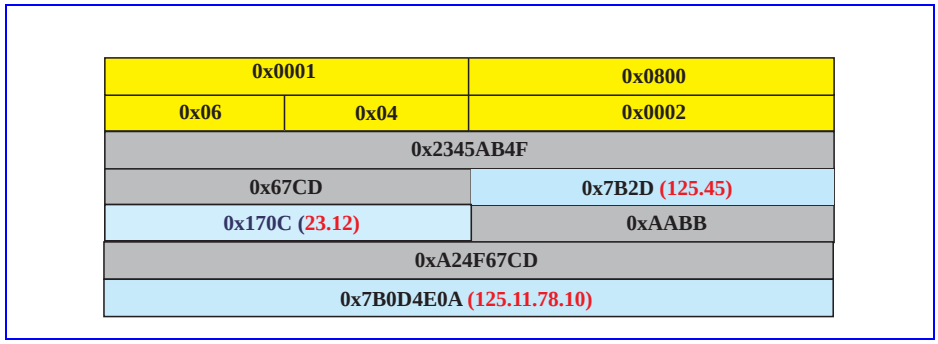
13. See Figure 21.1. Note that all values are in hexadecimal. Note also that the hardware addresses does not fit in the 4-byte word boundaries. We have also shown the IP address in parentheses.

Figure 21.1 *Solution to Exercise 13*



14. See Figure 21.2.

Figure 21.2 *Solution to Exercise 14*



15. See Figure 21.3. We have not shown the preamble and SFD fields, which are added in the physical layer.
16. See Figure 21.4. We have not shown the preamble and SFD fields, which are added in the physical layer.

Figure 21.3 *Solution to Exercise 15*

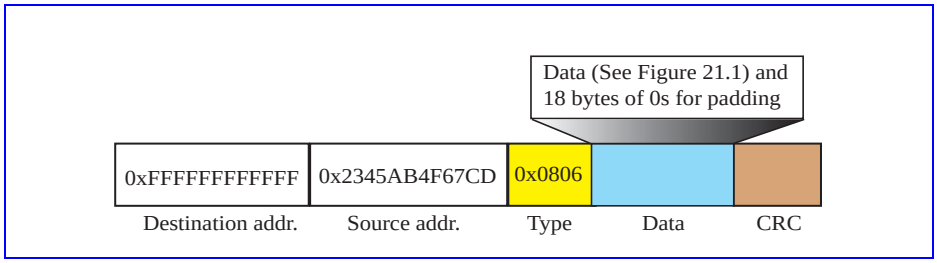
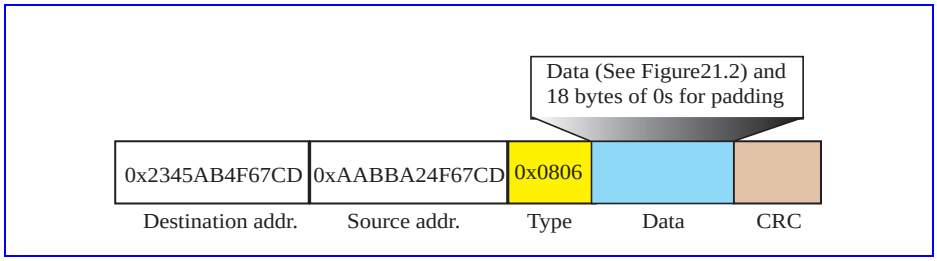


Figure 21.4 *Solution to Exercise 16*



17. It could happen that host B is unreachable, for some reason. The error message generated by an intermediate router could then be lost on its way back to host A. Or perhaps the datagram was dropped due to congestion and the error message generated by an intermediate router was lost.
18. The checksum is **0xD399** or **1101 0011 1001 1001** as calculated below:

		1	2	1	2	← Carry
8 and 0	→	**0**	**8**	**0**	**0**	
0	→	**0**	**0**	**0**	**0**	
123	→	**0**	**0**	**7**	**B**	
25	→	**0**	**0**	**1**	**9**	
H and e	→	**4**	**8**	**6**	**5**	
l and l	→	**6**	**C**	**6**	**C**	
o and pad	→	**6**	**F**	**0**	**0**	
		----	----	----	----	
Partial Sum		**2**	**C**	**6**	**5**	
Carry from last column					**1**	
Sum		**2**	**C**	**6**	**6**	
Checksum		**D**	**3**	**9**	**9**	

19. The appropriate ICMP message is ***destination unreachable*** message. This type of message has different types of codes to declare what is unreachable. In this case, the code is **0**, which means the network is unreachable (The codes are not discussed in the chapter; consult references for more information).

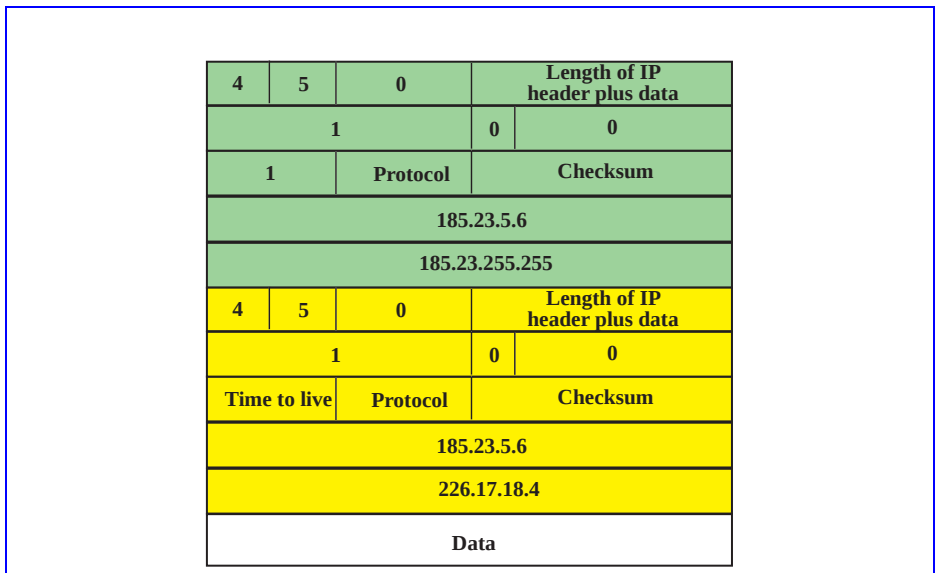
20. The appropriate ICMP message is ***destination unreachable*** message. This type of message has different types of codes to declare what is unreachable. In this case, the code is **3**, which means the port is unreachable (The codes are not discussed in the chapter; consult references for more information).
21. See the transformation process below:

IP:			**11100111**	**0**	**0011000**	**00111100**	**00001001**
Ethernet:	**00000001**	**00000000**	**01011110**	**0**	**0011000**	**00111100**	**00001001**

The Ethernet address in hexadecimal is **0x01005E183C09**

22. A router should send only **1** query message no matter how many entries it has in its group table. The message will be broadcast to all of the local nodes that are below it in the spanning tree.
23. The host must send as many as **five different report messages** at random times in order to preserve membership in five different groups.
24. The router will not need the services of ARP because the frame is broadcast at the physical address level. See Figure 21.5.

Figure 21.5 *Solution to Exercise 24*



25. No action should be taken.
26. It should set the state of the 2 entries to ***Delaying*** and start a timer for each with a random time. As each timer expires, a membership report message is sent twice for each group to the router that sent the query.

27.

Ethernet:
Supported number of groups using 23 bits = 2^{23} = **8,388,608 groups**
IP:
Supported number of groups using 28 bits =2^{28} = **268,435,456 groups**
Address space lost:
268,435,456 – 8,388,608 = **260,046,848 groups**

28. See below. We have shown the process in the solution to Exercise 21.

a.	**IP:** **234.18.72.8**	→	**Ethernet:**	**0x01005E124808**
b.	**IP:** **235.18.72.8**	→	**Ethernet:**	**0x01005E124808**
c.	**IP:** **237.18.6.88**	→	**Ethernet:**	**0x01005E120658**
d.	**IP:** **224.88.12.8**	→	**Ethernet:**	**0x01005E580C08**

Note that *a* and *b* represent the same Ethernet address.